

3/parts

JC20 Rec'd PCT/PTO 07 JUN 2005

1 DOWNHOLE TOOL WITH ACTUABLE BARRIER

2

3 The present invention relates to downhole tools for use
4 in cased or lined well bores for the oil and gas
5 industry, and in particular to a downhole tool which
6 includes a barrier between the tool body and well bore
7 wall which is actuatable to control fluid flow past the
8 tool.

9

10 It is considered desirable when drilling for oil or gas
11 to maintain a clean interior in the casing or liner of
12 the drilling well. For this purpose, well cleaning
13 equipment is well known and comes in a variety of
14 different forms, including casing scrapers, brushes and
15 circulation tools. Such equipment is used to free the
16 well tubing from debris particles, cement lumps, rocks,
17 congealed mud and so on.

18

19 Indeed well clean-up apparatus is used in an attempt to
20 clean the casing or other well tubing of even smaller
21 particles or debris such as oxidation lumps, scale and
22 burrs for example.

23

1
2 More advanced clean-up tools have also been developed
3 which filter the well fluid downhole. This is done to
4 remove the debris prior to production of the well. Such
5 filtering tools generally operate by providing a barrier
6 in the annulus between the tool body and the wall of the
7 well casing or liner. The barrier causes diversion of
8 fluid flowing past the tool into the tool. Once inside
9 the tool the fluid is passed through a filter and then
10 directed back into the annulus on the opposite side of
11 the barrier. Such a tool is that disclosed in GB 2335687.

12
13 A major disadvantage of these tools is that, as filtering
14 is required in one flow direction through the tool, a
15 second flow path through the tool must be provided for
16 fluid flow in the opposite direction so that the tool can
17 be run in and/or pulled out of the well bore without re-
18 dispersing the collected debris. This additional flow
19 path restricts the volume of fluid which can pass the
20 tool and may be prone to clogging if unfiltered well
21 fluid is required to take this flow path on running in.

22
23 It is an object of the present invention to provide a
24 downhole tool which allows for selective bypass of fluid
25 around the outer body of the tool.

26
27 It is a further object of at least one embodiment of the
28 present invention to provide a downhole tool with an
29 actuatable barrier which can be used to selectively divert
30 fluid through the tool body.

31
32 It is a yet further object of at least one embodiment of
33 the present invention to provide a downhole tool with an
34 actuatable barrier which can be used to selectively divert

1 fluid passing the tool body through the tool body when
2 the tool is run-in, pulled out or is stationary within
3 the well bore.

4

5 According to a first aspect of the present invention
6 there is provided a downhole tool for use in a cased or
7 lined well bore, the tool comprising a body connectable
8 in a work string, a fluid flow path through the tool body
9 and a barrier located at an outer surface of the tool,
10 wherein the barrier is actuatable to control fluid flow
11 passing the tool and selectively divert fluid flow
12 through the flow path.

13

14 When the barrier is not actuated the tool allows fluid
15 flow to run unimpeded in the annulus between the tool
16 body and the wall of the well bore. Conversely, the
17 barrier may be actuated to cause passage of fluid through
18 the tool.

19

20 Preferably the barrier comprises a resilient member which
21 when acted upon by actuating means deforms to extend the
22 member towards a wall of the well bore. The resilient
23 member may be a rubber ball. Alternatively the resilient
24 member may be an inflatable bladder.

25

26 Advantageously the barrier includes a surface engageable
27 with the well casing or liner. The surface may provide a
28 seal such that fluid is substantially restricted from
29 passing the tool. Thus the barrier is circumferentially
30 arranged on the outer surface of the tool body. Further
31 the barrier may be rotatable with respect to the tool
32 body. Advantageously also the surface is a wiper so that
33 as the tool is moved within the well bore the casing or
34 liner is cleaned when the surface is engaged.

1
2 Preferably the actuating means is a hydraulic actuator.
3 Hydraulic fluid may flow directly against the resilient
4 member to cause deformation. Alternatively the fluid may
5 act upon a piston member, wherein movement of the piston
6 member causes the resilient member to deform. In a first
7 embodiment the resilient member may be initially held in
8 compression by a retainer and the piston member releases
9 the retainer.
10
11 Advantageously, well fluid within the well bore may be
12 the hydraulic fluid to operate the actuating means.
13
14 Alternatively the actuating means may include a ball
15 valve. Thus the barrier may become actuatable through a
16 drop ball released at the surface and carried through a
17 bore in the work string. To selectively actuate the
18 barrier the drop ball may be deformable as are known in
19 the art. This is as disclosed in WO02/061236 for example.
20
21 The work string may be a pipe string, coiled tubing or a
22 wireline.
23
24 Preferably the tool includes an axial bore for fluid
25 circulation through the work string. Preferably also the
26 tool body is substantially cylindrical to provide the
27 annulus between the tool and the wall of the well bore.
28
29 There may be a plurality of fluid flow paths through the
30 tool body. One or more of the fluid flow paths may
31 include a filter so that well fluid can be filtered
32 downhole. Alternatively the fluid flow path may form a
33 hydraulic line for the actuation of a feature of the
34 downhole tool. Preferably the fluid flow path has an

5

1 inlet and an outlet. Preferably the inlet and outlet are
2 each arranged on an outer surface of the tool. Preferably
3 also the inlet and outlet are arranged on either side of
4 the barrier.

5

6 According to a second aspect of the present invention
7 there is provided a downhole tool for collecting loose
8 debris particles within a well bore, the tool comprising
9 a body connectable in a work string, a fluid flow path
10 through the tool body including means for filtering
11 debris particles and a barrier located at an outer
12 surface of the tool, wherein the barrier is actuatable to
13 control fluid flow passing the tool and selectively
14 divert fluid flow through the flow path.

15

16 The filtration means may be a wire screen sized to
17 prevent particles of a predetermined size from passing
18 therethrough. It will be appreciated however that many
19 different types of filtration apparatus may be used,
20 including permeable textiles, holed tubes or cages, and
21 so on. The filtration means need not be limited to any
22 one particular type of screen or filter, but may rather
23 comprise of a plurality of filters in series; the filters
24 being potentially of varying type and permeability.

25

26 The tool may also act as a collector or trap for debris
27 and the like. For example, a trap may be provided on the
28 up-stream side of the filter means for storing the
29 filtered debris.

30

31 Optionally, a separate filter may be provided for each
32 filtered flow path.

33

1 Preferably the barrier comprises a resilient member which
2 when acted upon by actuating means deforms to extend the
3 member towards a wall of the well bore. The resilient
4 member may be a rubber ball. Alternatively the resilient
5 member may be an inflatable bladder.

6

7 Advantageously the barrier includes a surface engageable
8 with the well casing or liner. The surface may provide a
9 seal such that fluid is substantially restricted from
10 passing the tool. Thus the barrier is circumferentially
11 arranged on the outer surface of the tool body. Further
12 the barrier may be rotatable with respect to the tool
13 body. Advantageously also the surface is a wiper so that
14 as the tool is moved within the well bore the casing or
15 liner is cleaned when the surface is engaged.

16

17 Preferably the actuating means is a hydraulic actuator.
18 Hydraulic fluid may flow directly against the resilient
19 member to cause deformation. Alternatively the fluid may
20 act upon a piston member, wherein movement of the piston
21 member causes the resilient member to deform. In a first
22 embodiment the resilient member may be initially held in
23 compression by a retainer and the piston member releases
24 the retainer.

25

26 Advantageously, well fluid within the well bore may be
27 the hydraulic fluid to operate the actuating means.

28

29 Alternatively the actuating means may include a ball
30 valve. Thus the barrier may become actuatable through a
31 drop ball released at the surface and carried through a
32 bore in the work string. To selectively actuate the
33 barrier the drop ball may be deformable as are known in
34 the art. This is as disclosed in WO02/061236.

1

2 The work string may be a pipe string, coiled tubing or a
3 wireline.

4

5 Preferably the tool includes an axial bore for fluid
6 circulation through the work string. Preferably also the
7 tool body is substantially cylindrical to provide the
8 annulus between the tool and the wall of the well bore.

9

10 There may be a plurality of fluid flow paths through the
11 tool body. Preferably the/each fluid flow path has an
12 inlet and an outlet. Preferably the inlet and outlet are
13 each arranged on an outer surface of the tool. Preferably
14 also the inlet and outlet are arranged on either side of
15 the barrier.

16

17 According to a third aspect of the present invention
18 there is provided a method of controlling fluid flow in a
19 well bore, comprising the steps:

20

- 21 (a) running a tool having an actuatable barrier on a work
22 string downhole;
- 23 (b) creating relative movement between the fluid in the
24 well bore and the tool;
- 25 (c) actuating the barrier to control fluid flow passing
26 the tool by varying the cross sectional area of the
27 annulus between the tool and the wall of the well
28 bore.

29

30 The method may further include the step of selectively
31 diverting fluid flow through a flow path in the tool.

32

33 Preferably the method may include the step of actuating
34 the barrier until the barrier sealingly engages the wall

1 of the well bore and thus substantially restricts fluid
2 flow passing the tool.
3
4 Additionally the method may include the step of filtering
5 the fluid flow through the flow path in the tool.
6
7 Embodiments of the present invention will now be
8 described, by way of example only, with reference to the
9 accompanying drawings of which:
10
11 Figure 1 is a part cross-sectional view through a
12 downhole tool according to a first embodiment of the
13 present invention;
14
15 Figure 2 is a part cross-sectional view through a
16 downhole tool according to a second embodiment of the
17 present invention; and
18
19 Figure 3 is a part cross-sectional view through a
20 downhole tool according to a third embodiment of the
21 present invention.
22
23 Reference is initially made to Figure 1 of the drawings,
24 which illustrates a downhole tool, generally indicated by
25 reference numeral 10, according to a first embodiment of
26 the present invention. Tool 10 comprises a generally
27 cylindrical body 12 having an axial bore 14 therethrough.
28 At an upper end 16 of the tool 10 there is provided a box
29 section (not shown) and at the lower end 18 of the tool
30 10 there is a pin section (not shown), as are known in
31 the art, for connecting the tool 10 to a work string (not
32 shown).
33

1 Around an inner mandrel 11 of the body 12 there is
2 located a sleeve 20. Sleeve 20 provides an inlet port 22
3 of annular shape at the upper end 16 of the tool 10. At
4 the lower end 18 is arranged a stop surface 24 to join
5 the sleeve 20 to the mandrel 11. In a portion of the wall
6 26 of the sleeve 20, towards the lower end 18, there is a
7 filter 28. Filter 28 is a cylindrical screen which can
8 filter loose debris and particles from fluid passing
9 through it. Together the sleeve 20 with filter 28 and
10 stop 24 provide a trap 30 where debris will collect when
11 fluid flow is in a direction marked by arrows A.

12

13 Between the mandrel 11 and the sleeve 20 are located
14 ports 32. Although a single port 32 is shown, typically
15 there will be a number of ports symmetrically arranged
16 around the mandrel 11. However sufficient space around
17 the ports 32 is provided for the entry of larger pieces
18 of debris to the trap 30. Mounted at an outlet 34 of the
19 port 32 is an inflatable seal 36. Seal 36 is
20 circumferentially arranged around the sleeve 20. Seal 36
21 is made of a resilient rubber which when inflated from
22 the inside will increase the size of the seal to fill the
23 annular space 38 between the tool 10 and the casing/liner
24 wall 40 of the well bore 42. When deflated the seal 36 is
25 afforded some protection by a lip 43 on sleeve 20 which
26 directs fluid toward the casing 40.

27

28 Within the mandrel is located a ball valve, generally
29 indicated by reference numeral 44. Valve 44 comprises a
30 seat 46 which is initially held to the mandrel 11 by a
31 shear pin 48. A stop 50 is also provided on the mandrel
32 11.

33

10

1 In use, tool 10 is run in well bore 42 through casing 40
2 on a work string (not shown). As shown on the left hand
3 side of Figure 1, the seal 36 is initially deflated so
4 fluid can flow upstream or downstream of the tool shown
5 by arrows B. This provides a large circulation path for
6 the fluid. Fluid can also flow through the axial bore 14
7 independently. Valve seat 46 is located across the
8 port(s) 32 to prevent the seal inflating. The valve seat
9 is held in position by the shear pin 48.

10

11 When fluid is required to be filtered, such as on pulling
12 out the tool 10 from the well bore 42, a ball 52 is
13 dropped from the surface into the axial bore 14. Ball 52
14 travels under fluid pressure to the seat 46 where it
15 blocks the passage of fluid through the bore 14. Pressure
16 then builds up behind the ball, sufficient to shear the
17 pin 48 and move the seat 46 downwards. The seat 46 will
18 fall to the stop 50, whereupon fluid within the bore can
19 now flow through port 32 to outlet 34 and fill the seal
20 36. Seal 36 consequently expands by inflation to fill the
21 annulus 38 and prevent fluid flow down the outside of the
22 tool 10 between the sleeve 20 and the casing 40. The
23 fluid flow to the seal 36 is regulated by a check valve
24 54 located in the port 32 to prevent over inflation of
25 the seal 36.

26

27 Seal 36 now engages the casing 40, as shown in the right
28 hand side of Figure 1. Seal 36 has a surface which is
29 suitable for continuous contact to the casing 40 while
30 the tool is moved within the casing 40. This surface is
31 typically a roughened rubber surface such as knobbles
32 which reduce the surface contact area without reducing
33 the quantity of fluid flow passed the tool 10. When tool
34 10 is moved, fluid is now directed into the annular port

1 22 and travels into the trap 30. The fluid is filtered by
2 passing through filter 28 and the clean fluid exits the
3 tool below the seal 36. Any debris filtered from the
4 fluid is caught within the sleeve 20 and falls against
5 stop 24 or is held in filter 28. Trap 30 can be emptied
6 when the tool 10 is removed from the well bore 42.

7
8 If filtering is not required at any time, that is if the
9 tool is to be further plunged into the well, fluid
10 pressure is increased through the axial bore 14. As valve
11 54 is closed, the increased pressure acts upon the drop
12 ball 52. Drop ball 52 is deformable and thus will be
13 extruded through the seat 46 and fall through the axial
14 bore 14. A ball catcher can be located further down the
15 work string to retrieve the ball 52. When extruded the
16 pressure drop in the bore 14 causes the check valve 54 to
17 open and fluid is released from the seal 36. Seal 36 then
18 deflates, just before spring 56 returns the valve seat 46
19 back over the port 32. The tool 10 is thus reset and seal
20 36 can be actuated as often as required by repeating the
21 process.

22
23 Reference is now made to Figure 2 of the drawings which
24 illustrates a downhole tool, generally indicated by
25 reference numeral 210, according to a second embodiment
26 of the present invention. Like parts to those of Figure 1
27 have been given the same reference numeral with the
28 addition of 200. The filter and trap arrangement are
29 included in the tool but are omitted from the Figure to
30 provide better clarity to the sealing arrangement.

31
32 In this second embodiment the valve seat 246 extends
33 through the sleeve 220 to provide a retainer cup 70 in
34 the annulus. Engaging slots are provided between the

12

1 sleeve 220 and the cup 70 to prevent a fluid path being
2 provided at this position on the tool.

3

4 Initially the retainer cup 70 retains a rubber ring 72
5 against the sleeve 220 to provide the passage past the
6 tool. On dropping the ball 252, to a similar ball valve
7 arrangement, the cup 70 is moved downwards and the ring
8 expands to fill the annulus 38. The tool 210 can then
9 operate in an identical manner to the tool 10 of Figure
10 1.

11

12 Reference is now made to Figure 3 of the drawings which
13 illustrates a downhole tool, generally indicated by
14 reference numeral 310, according to a third embodiment of
15 the present invention. Like parts to those of Figure 1
16 have been given the same reference numeral with the
17 addition of 300.

18

19 In likeness to the previous example embodiment, the
20 barrier in the embodiment of Figure 3 is a rubber ring
21 372. The ring 372 is shown in a non-actuated position in
22 the left hand section of the drawing, where it is
23 compressed against sleeve 320 by a drag block 370. The
24 drag block 370 is sufficiently slotted or ported so as to
25 enable fluid to flow through it, yet nevertheless it is
26 also adapted to undergo movement when drag forces
27 resulting from a predetermined flow of fluid act on it.
28 Thus in use, fluid can flow over the outside of the tool,
29 by the route of arrow B. Here the ring 372 is compressed
30 and held in position by the drag block 370. When fluid
31 pressure is increased by a predetermined amount or,
32 alternatively, the tool is pulled from the well bore, an
33 increase in pressure will occur on the surface 374 of
34 each drag block 370. Drag block 370 will then move

13

1 relative to the tool 310 and the ring 372 will be
2 released to expand and fill the annulus 38, thereby
3 redirecting fluid flow through the tool in the direction
4 of arrow A. The advantage of this embodiment is that the
5 barrier is actuated by the well fluid and a second
6 actuating fluid is not required.

7

8 The principal advantage of the present invention is that
9 it provides a downhole tool wherein fluid passing the
10 tool can be selectively diverted through the tool.

11

12 A further advantage of the present invention is that it
13 provides a downhole tool wherein fluid can be filtered
14 within a well bore when the tool is run in or pulled out
15 of the well bore.

16

17 It will be appreciated by those skilled in the art that
18 further modifications could be made to the invention
19 herein described without departing from the scope
20 thereof. For instance the ball valve could be released by
21 inserting a smaller steel ball to block the port 32 to
22 allow pressure to build up on the deformable ball 52.

23

24

25

26

27

28

29

30

31

32

33

34